Application No. 09/831,992   Attorney Docket No. PF990061

REMARKS

Claims 1-11 are pending in this application.

Rejection of Claim 1 under 35 USC § 112, First Paragraph

Claim 1 is rejected under 35 U.S.C. 112, first paragraph, as failing to comply with the enablement requirement.

Claim 1 of the present claimed invention recites a method for constructing a 3D scene model by analyzing image sequences. Each image corresponds to a viewpoint defined by its position and its orientation. A depth map corresponding to the depth in 3D space of the pixels of the image is calculated. Next, a resolution map corresponding to the 3D resolution of the pixels of the image from the depth map is calculated. A pixel of a current image is then matched with a pixel of another image of the sequence. Pixels relating to one and the same point of the 3D scene are determined by projecting the pixel of the current image onto the other image. Then, a pixel of the current image is selected depending on its resolution and on that of the pixels of other images of the sequence matched with this pixel. A 3D model is then constructed from the selected pixels.

The Office Action contends that the calculation of the depth map is not explained and that it is unclear as to whether the calculated depth maps for each image is within the scope of the invention. Applicant respectfully disagrees. Page 4, lines 26-31, of the specification describes "that by suitable processing, known from the prior art, we obtain, for each viewpoint, its 3D position in a reference frame associated with the scene (position and orientation of the viewpoint), as well as a depth map associated with the image relating to the viewpoint."

The depth maps can be created, for example, from two images using structure-from-motion algorithms, through active acquisition techniques (e.g. structured light) or passive acquisition techniques (e.g. laser scanning). U.S. Patent No. 5,793,900 titled

5

Application No. 09/831,992
"Generating Categorical Depth Maps Using Passive Defocus Sensing" and "A Stereo
Machine for Video-rate Dense Depth Mapping and Its New Applications (1996)" by T.
Kanade et al. are two documents that describe Z-buffering and depth map calculations.
Cited prior art PCT Application EP0735512 A2 also explains a way to calculate depth
information and mentions documents explaining such calculations (see page 3, §2:
creation of dept information).

Attorney Docket No. PF990061

Although standard cameras can be used for the acquisition of the images, a 3D
camera acquires depth information. Depth is measured by computing the time-of-flight
of a ray of light as it leaves the source and is reflected by the objects in the scene. The
round-trip time is converted to digital code independently for each pixel. Consequently,
one skilled in the art of image processing, for example by using specific cameras or
algorithms calculating the depth of the 3D points relating to the pixels of the image, is
able to calculate depth maps or Z-buffers.

In view of the above remarks, it is respectfully submitted that the specification
is fully enabling. Thus it is further respectfully submitted that this rejection is satisfied
and should be withdrawn.

Rejection of Claims 1, 9 and 11 under 35 USC § 102(e)

Claims 1, 9 and 11 are rejected under 35 U.S.C. 102(e) as being anticipated by
Davison et al.

The present claimed invention provides a method for constructing a 3D scene
model by analyzing image sequences. Each image corresponds to a viewpoint defined
by its position and its orientation. A depth map corresponding to the depth in 3D space
of the pixels of the image is calculated. Next, a resolution map corresponding to the 3D
resolution of the pixels of the image from the depth map is calculated. A pixel of a
current image is then matched with a pixel of another image of the sequence. Pixels
relating to one and the same point of the 3D scene are determined by projecting the

6

Application No. 09/831,992   Attorney Docket No. PF990061
pixel of the current image onto the other image. Then, a pixel of the current image is selected depending on its resolution and on that of the pixels of other images of the sequence matched with this pixel. A 3D model is then constructed from the selected pixels. The invention relates to a process for constructing a 3D scene model by analyzing image sequence.

Davison et al. neither disclose nor suggest "calculation, for an image, of a resolution map corresponding to the 3D resolution of the pixels of the image, from the depth map", as claimed in claim 1 of the present claimed invention. Davison et al. additionally neither disclose nor suggest "calculation, for an image, of a depth map corresponding to the depth, in 3D space, of the pixels of the image", as claimed in claim 1 of the present claimed invention. Davison et al. also neither disclose nor suggest "selection of a pixel of the current image depending on its resolution and on that of the pixels of other images of the sequence matched with this pixel" as claimed in claim 1 of the present claimed invention.

In the present claimed invention, the 3D resolution is defined throughout the specification, and more specifically on page 5, lines 14-21. For each of the pixels belonging to a window, the depth information is processed so as to determine, from the distribution in 3D space of the points around the processed pixel, the 3D resolution. For a current pixel, its 3D resolution depends on the depth of neighboring 2D pixels. After processing all the pixels of the image, a resolution map of the image is obtained for each of the images of the sequence and the range of the depth values of these pixels determines the resolution. Furthermore, in the present claimed invention, an image corresponds to a viewpoint defined by its position and its orientation. Starting from a pixel of the image i, it is possible to determine its projection point in an image j via known geometrical transformation, as described on page 8, lines 20-21. The present claimed invention aims to create a process allowing for improvement in the possibilities of navigation in the virtual scene.

Davison et al. describe an apparatus and method for creating three-dimensional models of an object. The images of the object are taken from different unknown

7

Application No. 09/831,992
positions and are processed to identify the points in the images which correspond to the
same point on the actual object. The matching points are used to determine the relative
positions from which the images are taken, and the matching points and calculated
positions are used to calculate points in a 3D space representing points on the object.

Attorney Docket No. PF990061

Relating to the depth map, the Office Action interprets the camera orientation
and the positions as depth maps because the points in the image are determined
relative to their capture viewpoints. The Office Action further interprets the resolution
"as being necessary to matching points or features". The definition of a depth map or
a 3D resolution, however, does not allow such an assimilation which is considered by
the applicant as a hindsight approach. The definition of a 3D resolution, as provided
in our previous response, is the distribution of the points of the 3D scene related to
pixels around the processed pixel allowing the determination of resolution
(Specification, page 5, lines 14-21). A resolution corresponds to a number of points (a
distribution) within a given range (a given depth value). Davison et al. consider
distances between 3D points relating to only a point of the 3D scene, but calculated by
different cameras. Davison et al., however, neither disclose nor suggest "calculation,
for an image, of a resolution map corresponding to the 3D resolution of the pixels of
the image, from the depth map", as claimed in claim 1 of the present claimed
invention.

The calculation of z values in Davison et al. is not the same as the calculation
of a 3D resolution as in the present claimed invention. In the present claimed
invention, the calculation of a 3D resolution, or the use of a 3D resolution map for a
selection step as these z values, are processed by matching only 3D points and
calculating a standard deviation of the z-coordinates,. Davison et al. do not require
density of point in the scene, and does not suggest such a calculation to perform this
matching. Thus, Davison et al. neither disclose nor suggest "calculation, for an image,
of a depth map corresponding to the depth, in 3D space, of the pixels of the image", as
claimed in claim 1 of the present claimed invention.

8

Application No. 09/831,992
Attorney Docket No. PF990061

The Office Action contends that a resolution must be determined in order to match the points and to represent points in 3D space, as the figures illustrate. Applicant respectfully disagrees as calculating a 3D resolution to match the points corresponding to different camera positions is not necessary. Furthermore, Davison et al. do not disclose or suggest the calculation of a 3D resolution which is a characteristic of the present claimed invention.

Additionally, the Office Action, citing steps 558-560, Fig. 44a, contends that Davison et al. disclose selecting a pixel of the current image depending on its resolution, referring to the shift or distance between pixels. The selection in Davison et al., however, corresponds to accuracy. Applicant respectfully submits that accuracy is not the same as resolution. Thus, Davison et al. neither disclose nor suggest "selection of a pixel of the current image depending on its resolution and on that of the pixels of other images of the sequence matched with this pixel" as claimed in claim 1 of the present claimed invention.

While Davison et al. describe a determining shift, this determining shift refers to "errors" or "shifts" between pixels or clusters of 3D pints. The cluster relates only to a point of an object in 3D space. The representation of only a point of an object in 3D space can not be assimilated to a 3D resolution. The resolution requires at least the calculation of the distance between two different 3D points of a 3D scene. Assimilating an error relating to the position of a point in 3D space to a 3D resolution is not a broad interpretation of a 3D resolution. Furthermore, in Davison et al., the points correspond to a single point on the surface of the actual object 24 (Davison et al., col. 43, line 63). This shift is the error relating to the same 3D point when using different cameras.

Step S558 of Davison et al. determines whether the magnitude of the shift calculated at step S554 is greater than 10% of the object size calculated at step S552. If the shift is greater than 10%, the point under consideration for the current pair of camera positions and the corresponding point for the subsequent pair of camera positions are considered to be inaccurate and discarded at S560 (Davison et al.,

9

Application No. 09/831,992
column 44, lines 6-24). As a result, the shift or inter-point distance represents an error. Although the shift corresponds to different pixels in the 2D representation, the shift relates to only a 3D point. Thus, the shift represents <u>simply a single point in space</u> as opposed a distance between two 3D points. As this shift provide only 2D accuracy and relates only to a 3D point, this shift can not be the distances between two different 3D points and consequently can not be considered 3D resolution.

Davison et al. also describe the use of grid squares of different sizes to determine density of point s in the respective images to be matched. "The number and density of points in the first image of the pair to be considered for matching..." (Davison et al., col. 21, line 20-21) clearly describe a 3D resolution. The present claimed invention defines a 2D resolution as an image comprising pixels, or a calculation of a resolution map or density of points within an image. A 3D resolution, however, relates to these pixels or resolution maps in correspondence to a number of 3D points within a depth range.

Consequently, inter-point distance, as described in Davison et al., can not be assimilated to 3D resolution. Inter-point distance only provides accuracy in 2D. Thus, Davison et al., even when broadly interpreted, does not anticipate claim 1 of the present invention.

In view of the above remarks it is respectfully submitted that there is no 35 USC 112 compliant enabling disclosure in Davison et al. showing the above discussed features. As claims 9 and 11 are dependant on claim 1 it is respectfully submitted that these claims are allowable for the same reasons as discussed above. It is thus further respectfully submitted that claims 1, 9 and 11 are not anticipated by Davison et al. It is thus, further respectfully submitted that this rejection is satisfied and should be withdrawn.

10

Application No. 09/831,992   Attorney Docket No. PF990061
Rejection of Claim 2 under 35 USC § 103(a)

Claim 2 is rejected under 35 U.S.C. 103(a) as being unpatentable over Davison et al., in view of Azarbayejani et al. (U.S. Patent 5,511,153).

Similarly to Davison et al., Azarbayejani et al. neither disclose nor suggest "calculation, for an image, of a resolution map corresponding to the 3D resolution of the pixels of the image, from the depth map", as claimed in claim 1 of the present claimed invention. Azarbayejani et al., also similarly to Davison et al., neither disclose nor suggest "calculation, for an image, of a depth map corresponding to the depth, in 3D space, of the pixels of the image", as claimed in claim 1 of the present claimed invention.

Azarbayejani et al. describe a method and apparatus for generating a three-dimensional, textured computer model from a series of video images. The invention operates by tracking a selected group of object features through a series of image frames, and based on their relative positions, estimates parameters specifying camera focal length, translation and rotation, and the positions of the tracked features in the camera reference frame. Unlike the present claimed invention, Azarbayejani et al. are not concerned with calculating a resolution map corresponding to the 3D resolution of pixels of the image from the depth map. Azarbayejani et al are also not concerned with calculating a depth map corresponding to the depth in 3D space of the pixels of the image. Thus, similarly to Davison et al., Azarbayejani et al. neither disclose nor suggest "calculation, for an image, of a resolution map corresponding to the 3D resolution of the pixels of the image, from the depth map", as claimed in claim 1 of the present claimed invention. Azarbayejani et al., also similarly to Davison et al., neither disclose nor suggest "calculation, for an image, of a depth map corresponding to the depth, in 3D space, of the pixels of the image", as claimed in claim 1 of the present claimed invention.

Additionally, the combination of Azarbayejani et al. and Davison et al. would not produce the present claimed invention. This combination would produce an image

11

Application No. 09/831,992
                                                    Attorney Docket No. PF990061
processing apparatus for creating a 3D textured computer model form a series of
video games. This combination neither discloses nor suggests "calculation, for an
image, of a resolution map corresponding to the 3D resolution of the pixels of the
image, from the depth map", as claimed in claim 1 of the present claimed invention.
The combined system also neither disclose nor suggest "calculation, for an image, of
a depth map corresponding to the depth, in 3D space, of the pixels of the image", as
claimed in claim 1 of the present claimed invention.

In view of the above remarks it is respectfully submitted that there is no 35 USC
112 compliant enabling disclosure contained within Davison et al. and Azarbayejani et
al., when taken alone or in combination, showing the above discussed features. It is
thus further respectfully submitted that the present claimed invention is patentable over
Davison et al. and Azarbayejani et al., when taken alone or in combination. As claim 2
is dependent on claim 1, it is respectfully submitted claim 2 is allowable for the same
reasons discussed above regarding independent claim 1. Thus, it is further respectfully
submitted that this rejection is satisfied and should be withdrawn.

Rejection of Claims 4, 5 under 35 USC § 103(a)

Claims 4 and 5 are rejected under 35 U.S.C. 103(a) as being unpatentable over
Davison et al., in view of McAllister et al. (Real-Time rendering techniques of real
world environments).

Similarly to Davison et al., McAllister et al. neither disclose nor suggest
"calculation, for an image, of a resolution map corresponding to the 3D resolution of
the pixels of the image, from the depth map", as claimed in claim 1 of the present
claimed invention. McAllister et al., also similarly to Davison et al., neither disclose
nor suggest "calculation, for an image, of a depth map corresponding to the depth, in
3D space, of the pixels of the image", as claimed in claim 1 of the present claimed
invention.

12

Application No. 09/831,992   Attorney Docket No. PF990061

McAllister et al. recite an end-to-end system for acquiring highly detailed scans of large real world spaces, consisting of forty to eighty million range and color samples, using a digital camera and laser rangefinder. Unlike the present claimed invention, McAllister et al. are not concerned with calculating a resolution map corresponding to the 3D resolution of pixels of the image from the depth map. McAllister et al. are also not concerned with calculating a depth map corresponding to the depth in 3D space of the pixels of the image. Thus, similarly to Davison et al., McAllister et al. neither disclose nor suggest "calculation, for an image, of a resolution map corresponding to the 3D resolution of the pixels of the image, from the depth map", as claimed in claim 1 of the present claimed invention. McAllister et al., also similarly to Davison et al., neither disclose nor suggest "calculation, for an image, of a depth map corresponding to the depth, in 3D space, of the pixels of the image", as claimed in claim 1 of the present claimed invention.

Additionally, the combination of McAllister et al. and Davison et al. would not produce the present claimed invention. This combination would produce an end-to-end system for acquiring highly detailed scans of large real world spaces using a digital camera and laser rangefinder for processing 3D models of objects. This combination neither discloses nor suggests "calculation, for an image, of a resolution map corresponding to the 3D resolution of the pixels of the image, from the depth map", as claimed in claim 1 of the present claimed invention. The combined system also neither disclose nor suggest "calculation, for an image, of a depth map corresponding to the depth, in 3D space, of the pixels of the image", as claimed in claim 1 of the present claimed invention.

In view of the above remarks it is respectfully submitted that there is no 35 USC 112 compliant enabling disclosure contained within Davison et al. and McAllister et al., when taken alone or in combination, showing the above discussed features. It is thus further respectfully submitted that the present claimed invention is patentable over Davison et al. and McAllister et al., when taken alone or in combination. As claims 4 and 5 are dependent on claim 1, it is respectfully submitted they are allowable for the

13

Application No. 09/831,992   Attorney Docket No. PF990061
same reasons discussed above regarding independent claim 1. Thus, it is further
respectfully submitted that this rejection is satisfied and should be withdrawn.

Rejection of Claim 10 under 35 USC § 103(a)

Claim 10 is rejected under 35 U.S.C. 103(a) as being unpatentable over Davison
et al., in view of La Roux et al. (An Overview of Moving Object Segmentation in
Video Images, IEEE, 1991).

Similarly to Davison et al., La Roux et al. neither disclose nor suggest
"calculation, for an image, of a resolution map corresponding to the 3D resolution of
the pixels of the image, from the depth map", as claimed in claim 1 of the present
claimed invention. La Roux et al., also similarly to Davison et al., neither disclose nor
suggest "calculation, for an image, of a depth map corresponding to the depth, in 3D
space, of the pixels of the image" as claimed in claim 1 of the present claimed
invention.

La Roux et al. disclose a method for modelling a 3D object from an image
sequence. 3D objects are modelled by combining state-of-the-art algorithms for un-
calibrated projective reconstruction, self calibration and dense correspondence
matching. Unlike the present claimed invention, La Roux et al. are not concerned with
calculating a resolution map corresponding to the 3D resolution of pixels of the image
from the depth map. La Roux et al. are also not concerned with calculating a depth
map corresponding to the depth in 3D space of the pixels of the image. Thus,
similarly to Davison et al., La Roux et al. neither disclose nor suggest "calculation, for
an image, of a resolution map corresponding to the 3D resolution of the pixels of the
image, from the depth map", as claimed in claim 1 of the present claimed invention.
La Roux et al., also similarly to Davison et al., neither disclose nor suggest
"calculation, for an image, of a depth map corresponding to the depth, in 3D space, of
the pixels of the image", as claimed in claim 1 of the present claimed invention.

14

Application No. 09/831,992

Attorney Docket No. PF990061

Additionally, the combination of La Roux et al. and Davison et al. would not produce the present claimed invention. This combination would produce an apparatus for processing 3D models of objects from an image sequence. This combination neither discloses nor suggests "calculation, for an image, of a resolution map corresponding to the 3D resolution of the pixels of the image, from the depth map", as claimed in claim 1 of the present claimed invention. The combined system also neither disclose nor suggest "calculation, for an image, of a depth map corresponding to the depth, in 3D space, of the pixels of the image", as claimed in claim 1 of the present claimed invention.

In view of the above remarks it is respectfully submitted that there is no 35 USC 112 compliant enabling disclosure contained within Davison et al. and La Roux, when taken alone or in combination, showing the above discussed features. It is thus further respectfully submitted that the present claimed invention is patentable over Davison et al. and La Roux, when taken alone or in combination. As claim 10 is dependent on claim 1, it is respectfully submitted claim 10 is allowable for the same reasons discussed above regarding independent claim 1. Thus, it is further respectfully submitted that this rejection is satisfied and should be withdrawn.

Claims 3 and 6-8 have been allowed. In view of the above remarks, it is respectfully submitted that claims 1, 2, 4, 5 and 9-11 are allowable.

Having fully addressed the Examiner's rejections, it is believed that, in view of the preceding remarks, this application stands in condition for allowance. Accordingly then, reconsideration and allowance are respectfully solicited. If, however, the Examiner is of the opinion that such action cannot be taken, the Examiner is invited to contact the applicant's attorney at the phone number below, so that a mutually convenient date and time for a telephonic interview may be scheduled.
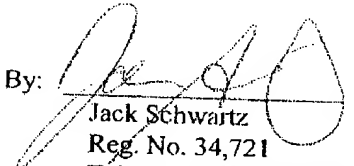
15

Application No. 09/831,992   Attorney Docket No. PF990061
          No fee is believed due. However, if a fee is due, please charge the additional fee
to Deposit Account 07-0832.

                                             Respectfully submitted,
                                             Yannick Nicolas

                                    By: _____
                                             Jack Schwartz
                                             Reg. No. 34,721
                                             Tel. No. (609)734-6866
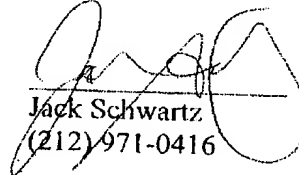

Thomson Licensing Inc.
Patent Operations
PO Box 5312
Princeton, NJ 08543-5312
May 4, 2006

                                    16

Patent Application No.: 09/831,992   Attorney Docket No. PF990061

Certificate of Facsimile Transmission

I hereby certify that this paper is being transmitted by facsimile transmission to Examiner Tucker at facsimile telephone number (571) 273-8300 on Thursday, July 27, 2006.

July 27, 2006
Date

Jack Schwartz
(212) 971-0416